Green Diamond Resource Company's Annual Report

To

National Marine Fisheries Service

For

Permit 1060 – Mod 1

Juvenile Salmonid Outmigrant Trapping Program

Little River

2012

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Introduction

In 2012, Green Diamond Resource Company (GDRCo) conducted its fourteenth year of outmigrant trap monitoring in Little River, under a National Marine Fisheries Service (NMFS) Section 10 Permit (1060-Mod 1). This monitoring project has been conducted in Little River since 1999 and in 2007 became part of the Effectiveness Monitoring Program under an approved Aquatic Habitat Conservation Plan (AHCP; GDRCo 2006). The purpose of the Effectiveness Monitoring Program is to track the success of the AHCP conservation program in relation to the biological goals and objectives and provide a basis for adaptive management.

The Little River watershed provides habitat for ESA listed salmonids from the Southern Oregon/North Coastal California (SONCC) coho salmon evolutionarily significant unit (ESU), California Coastal Chinook salmon ESU, and Northern California steelhead distinct population segment (DPS). The objectives of the outmigrant trapping project in the Little River watershed are to monitor the abundance, size, and timing of emigrating salmonid smolts for these species and coastal cutthroat trout. Over time the results of this monitoring effort will provide information on long term trends in any of these variables. Comparisons of the outmigrant population estimate to a summer population estimate (where available) can also be made to yield an apparent overwinter survival rate for the juvenile coho population. Juvenile outmigrant trapping helps to identify factors affecting outmigration timing, and establish baseline and long-term trend data on the abundance of juvenile salmonid populations.

Outmigrant trapping was conducted in Little River from April 14th through June 29th, 2012. This document reports findings for the 2012 season and makes select comparisons to past monitoring in Little River.

Methods

Study Site

Outmigrant trapping was conducted at four sites in the Little River watershed (Figure 1). Traps were operated on Lower South Fork Little River (LSFLR, drainage area ≈ 5.31 mi^2), Upper South Fork Little River (USFLR, ≈ 5.70 mi^2), Carson Creek (CC, ≈ 3.81 mi^2) and Railroad Creek (RRC, ≈ 2.75 mi^2). There is approximately 3.0, 2.0, 3.5, and 0.7 miles of known coho habitat above these sites, respectively. However, the amount of habitat above each monitoring site varies from year to year, as a result of dynamic stream processes. All trap sites are located near the confluence of each creek with mainstem Little River. These creeks are all located within the Little River hydrographic planning area (HPA, GDRCo 2006) and lands within each monitored sub-basin are entirely or predominantly owned by GDRCo.

Outmigrant Trapping

Outmigrant trapping was conducted using a V-notch weir, pipe, and a live-box. The weirs were constructed with fence posts and wooden pallets and buttressed with large substrates (e.g., cobbles and boulders). A weir overflow was constructed to provide passage for adult migrants moving upstream to spawn. The pipe runs from the center of the “V” in the weir and empties out onto a McBain’s ramp that dissipates water velocity of the outflow and guides fish into the trap box. Inside the trap, a V-shaped panel creates a

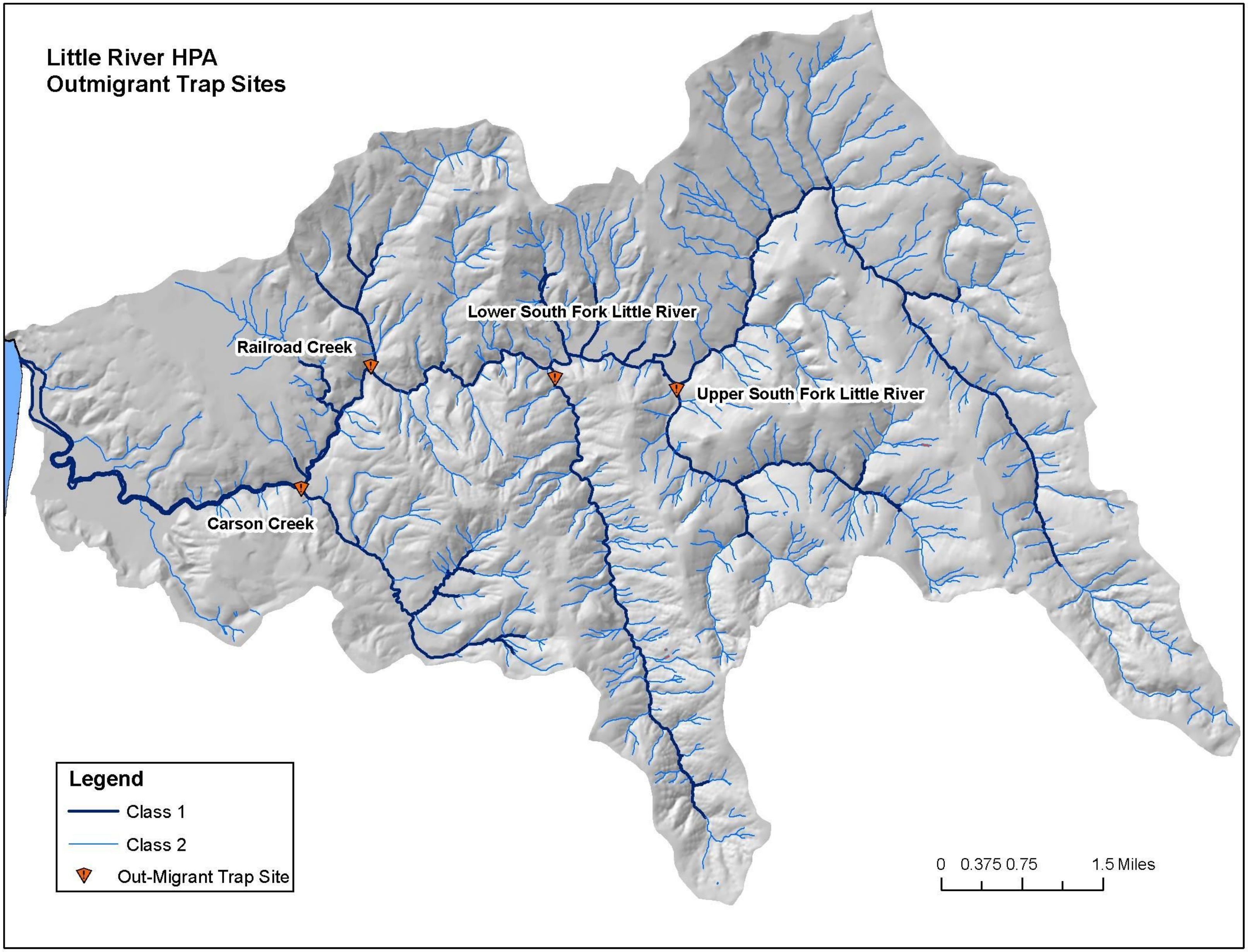

Figure 1. Map of the Little River Hydrolographic Planning Area (HPA) and locations of the outmigrant trap sites in four monitored sub-basins.

large slack water area in the box. The slack water area provides a place where fish are protected from the current of the stream. A secondary box was attached to the primary trap box to reduce in-trap predation. Mesh screen (mesh size = ½ inch) at the entrance of the back-box served as a barrier to segregate the larger fish from the smaller fish. To further prevent predation, cobbles and a circular mesh enclosure (mesh size = ½ inch) was provided in the primary trap box (i.e., forward-box) to serve as refugia for young-of-the-year (YOY) fish.

The traps were operated 24 hours a day, 7 days a week. During periods when significant numbers of outmigrants were captured or when accumulations of debris were likely, the traps were checked more than once per day, as necessary. Juvenile salmonid mortality has been associated with heavy debris loading in the trap-box during periods of high winds and high flows (GDRCo, 2011). During these conditions is when additional visits typically occurred.

The data collecting and handling procedures for captured fish varied depending on species and age class. Each day, all captured fish were at least identified, aged, and tallied. Due to the similarities between YOY steelhead and YOY cutthroat trout, proper identification is problematic (Baumsteiger et al., 2005 and Voight et al., 2008), therefore these species were categorized as "trout". All "trout" were YOY fish. Steelhead and cutthroat trout in the 1+ or older age classes were distinguishable between species. Adult cutthroat were defined as fish >200 mm with no signs of smoltification. Among YOY salmonids captured each day, the first 20 fish of each species at each site were measured (fork length, [FL], ± 1 mm). Weights (± 0.1 gram) were also collected for the measured fish one day per week at each site. Among 1+ fish and adult cutthroat captured each day, the first 20 fish of each species were measured and weighed at each site. All adult steelhead were measured but not weighed. Unmarked fish were released downstream from the trap site after processing and handling. Among smolts, a sub-sample were marked and released upstream of the trap to estimate trapping efficiency (see below for details). Prior to marking, fish were anesthetized with Alka-Seltzer Gold®, identified, weighed, and measured. After recovery, marked fish were released upstream of the weir.

Trap Efficiency

Trap efficiency was calculated only for species that were actively leaving the watershed on their seaward migration (i.e., smolts). Smolts were identified using distinct morphological characteristics including; fading parr marks, scale color transition towards silver, and fins turning clear with dark tips. Four different caudal fin clips were used as marks throughout the trapping effort on a seven-day rotating period: upper horizontal, upper vertical, lower vertical, and lower horizontal caudal. After the first twenty-eight days, the same sequence of clips was repeated. Up to 20 smolts of each species were marked every day for trap efficiency tests.

Caudal fin clips were retained from 2004 - 2009 and were provided to National Oceanographic and Atmospheric Administration (NOAA), Southwest Fisheries Science Center, Santa Cruz, CA in January 2010 for storage and molecular genetic analysis. Fin clips were not retained in 2010, based on discussions with NOAA, but collection resumed in 2011 and continued in 2012.

Marked fish were allowed to recover in a perforated livebox that was located upstream of each trap site. The livebox has an automatic release device which was programmed to release fish 10 hours following capture. This release time allowed fish ample recovery time and provided cover (i.e., darkness) during their release to minimize predation.

Recaptured fish were released downstream from the trap site to avoid pseudoreplication in calculations of capture probabilities.

Gastric Lavage

Gastric lavage (i.e., stomach pumping) was conducted from 1999 - 2001 to quantify predation related to outmigrant trapping efforts but has since been suspended. Predation mortality associated with the outmigrant trapping effort has always been a concern of GDRCo fisheries staff, however, the gastric lavage portion of the trapping efforts was discontinued because of the unnecessarily excessive handling of individual fish. This process introduces additional stress to sampled individuals both directly, through the insertion of the tube, and indirectly by denying them the benefits from acquired prey.

Despite discontinuing gastric lavage, GDRCo staff continue to develop new methods to reduce in-trap predation. This component may be reinstated to our monitoring once a new trap technique is developed that minimizes in-trap predation, or when a study design is developed to differentiate in-trap predation rates from natural predation rates.

Population Estimates

All outmigrant salmonid smolt population estimates were calculated using the Darroch Analysis with Rank Reduction (DARR 2.0.1 software) for analysis of stratified mark-recapture data (Bjorkstedt, 2005), where possible. Due to low capture or recapture numbers, or other circumstances, it was not possible to generate population estimates for all years and species. In these cases, only hard counts are shown. The hard count numbers are labeled and depicted without error bars.

Summer juvenile population estimates were conducted using the GDRCo Single Stream Population Estimate protocol (GDRCo, 2013). Summer coho population estimates presented here for use in estimating apparent overwinter survival were generated using the latest Mohr and Hankin (2005) estimators of abundance and variance with bias adjustments to reduce the bias of the bounded counts and jackknife estimators.

While all historical data have been audited for accuracy and consistency as for this report, GDRCo maintains and periodically updates a data quality routine that may detect previously unidentified errors. Estimates presented in this report that differ from previously reported figures should be considered the most accurate.

Coho Overwinter Survival

The apparent overwinter survival of coho salmon was calculated by dividing the smolt population estimate by the prior summer's juvenile population estimate. One assumption for this method of calculation is that the monitored population is closed.

An overwinter survival estimate cannot be calculated for Carson Creek because site conditions prohibit use of the standard GDRCo Juvenile Summer Abundance survey protocols. Carson Creek has dark tannic water and an abundance of complex deep pools with large woody debris that are very difficult to dive or electrofish effectively.

Stream Temperature

Water temperature was monitored at each site during the 2012 trapping season and these data were used to document the water temperatures trapped fish were exposed to during the latter portion of the trapping season. Water temperatures were measured using HOBO® Water Temp Pro v^2 data loggers (Onset Computer Corporation, Bourne, MA). Data loggers were attached to the bottom of a t-post installed adjacent to the trap box and recorded water temperature (ºC) on a 72 minute interval. Water temperature monitoring was not conducted in the early portion of the trapping periods because past monitoring efforts in Little River showed that water temperatures remain cold and stable during this time (unpublished data).

Results

Trapping Effort

The 2012 trapping effort was summarizes and compiled with all other years to allow for comparison over the history of outmigrant trapping in the Little River watershed (Table 1). In 2012, outmigrant traps were in operation for 100% of the trapping season. This was the fifth year where traps were operable for the entire season, except at Railroad Creek where it was the sixth year. The overall mean proportion of operable days across years was 92.6%. Despite relatively high rainfall during the trapping season, stream discharges did not exceed levels to prohibit trapping. The initiation of trapping in 2012 was the latest start of the trapping seasons to date. High flow in early spring prevented earlier installation of the traps. As a result, the length of the 2012 monitoring season (68 days) was shorter than average (86 days).

Trap Efficiency

Trapping efficiency varied among sites and was not calculated for Railroad Creek due to insufficient captures. The change in trapping efficiency varied both among sites and during the season (Figure 2). Efficiency was lowest during the beginning of the season and generally improved by the fifth week. Average mean trap efficiency (i.e., capture probability) for coho smolts during the 2012 trapping season was 78% (Range = 26 – 100%). Compared to past years, average trap efficiency in 2012 was within the range previously documented (56-85%) in Little River.

Population Estimates

During the 2012 outmigrant trapping season, a total of 1,366 salmonid smolts were captured. Table 2 summarizes the number of captures (i.e., marked and unmarked fish), marked, and recaptured fish for each species. Coho accounted for nearly all (99.6%) of the smolt captures. Among smolts, the proportion of coho, steelhead, and cutthroat marked at all trapping sites combined were 75%, 100%, 100%, respectively.

In 2012, smolt population estimates were calculated for all salmonids at each monitoring site where possible (Table 3) and compared to the past thirteen years (Figures 3-5). Smolt estimates for coho, steelhead, and cutthroat were all variable among sites and there was no clear or consistent pattern over time. Coho smolt estimates were highest in CC and LSFLR followed by USFLR and only one coho was detected at RRC (Figure 3). Compared to 2011, coho numbers were generally the same at each of the four sites.

Table 1. Summary of the 2004 – 2012 outmigrant trapping (OMT) seasons conducted by GDRCo in the Little River watershed, Humboldt County, California.

		Year															
Site	**OMT parameter**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**	**Total**
USF Little River	Initiation date	16-Mar	4-Mar	28-Feb	19-Feb	3-Mar	11-Mar	25-Feb	11-Apr	15-Mar	12-Mar	2-Apr	29-Mar	9-Apr	14-Apr	16-Mar	-
	Completion date	7-Jul	14-Jun	4-Jun	31-May	11-Jun	28-May	3-Jun	7-Jun	14-Jun	12-Jun	19-Jun	8-Jun	11-Jun	29-Jun	11-Jun	-
	Season days	111	100	96	102	98	77	98	56	89	90	77	69	62	75	85.7	1200
	Operable days	105	100	96	102	73	76	38	55	88	90	74	63	58	75	78.1	1093
	Operable %	95%	100%	100%	100%	74%	99%	39%	98%	99%	100%	96%	91%	94%	100%	91.8%	-
	Inoperable days	6	0	0	0	25	1	60	1	1	0	3	6	4	0	7.6	107
	Inoperable %	5%	0%	0%	0%	26%	1%	61%	2%	1%	0%	4%	9%	6%	0%	8.2%	-
LSF Little River	Initiation date	17-Mar	7-Mar	21-Feb	19-Feb	3-Mar	11-Mar	25-Feb	7-Apr	15-Mar	12-Mar	2-Apr	29-Mar	9-Apr	14-Apr	16-Mar	-
	Completion date	7-Jul	16-Jun	4-Jun	5-Jun	11-Jun	28-May	3-Jun	14-Jun	21-Jun	19-Jun	19-Jun	29-Jun	18-Jun	15-Jun	14-Jun	-
	Season days	110	99	103	106	98	77	98	67	96	97	77	90	69	61	89.1	1248
	Operable days	102	99	99	106	74	76	42	67	94	97	74	79	65	61	82.6	1135
	Operable %	93%	100%	96%	100%	76%	99%	43%	100%	98%	100%	96%	88%	94%	100%	90.9%	-
	Inoperable days	8	0	4	0	24	1	56	0	2	0	3	11	4	0	8.1	113
	Inoperable %	7%	0%	4%	0%	24%	1%	57%	0%	2%	0%	4%	12%	6%	0%	8.4%	-
Railroad Creek	Initiation date	16-Mar	29-Feb	19-Feb	19-Feb	3-Mar	11-Mar	25-Feb	12-Apr	15-Mar	12-Mar	26-Mar	29-Mar	9-Apr	14-Apr	15-Mar	-
	Completion date	9-Jun	7-Jun	31-May	31-May	31-May	28-May	3-Jun	31-May	31-May	29-May	29-May	2-Jun	4-Jun	15-Jun	2-Jun	-
	Season days	83	97	102	102	88	77	98	49	76	77	63	63	55	61	79.2	1170
	Operable days	83	96	102	102	75	76	27	49	75	77	60	59	51	61	71.7	1065
	Operable %	100%	99%	100%	100%	85%	99%	28%	100%	99%	100%	95%	94%	93%	100%	91.6%	-
	Inoperable days	0	1	0	0	13	1	71	0	1	0	3	4	4	0	7.0	98
	Inoperable %	0%	1%	0%	0%	15%	1%	72%	0%	1%	0%	5%	6%	7%	0%	7.8%	-
Carson Creek	Initiation date	-	31-Mar	19-Feb	19-Feb	3-Mar	11-Mar	25-Feb	6-Apr	15-Mar	12-Mar	26-Mar	29-Mar	9-Apr	14-Apr	17-Mar	-
	Completion date	-	16-Jun	5-Jun	5-Jun	11-Jun	28-May	3-Jun	14-Jun	21-Jun	26-Jun	19-Jun	29-Jun	18-Jun	29-Jun	14-Jun	-
	Season days	-	76	106	106	98	77	98	68	96	104	83	90	69	75	88.2	1146
	Operable days	-	76	106	106	84	73	85	66	95	104	81	83	65	75	84.5	1099
	Operable %	-	100%	100%	100%	86%	95%	87%	97%	99%	100%	98%	92%	94%	100%	95.9%	-
	Inoperable days	-	0	0	0	14	4	13	2	1	0	2	7	4	0	3.6	47
	Inoperable %	-	0%	0%	0%	14%	5%	13%	3%	1%	0%	2%	8%	6%	0%	4.1%	-

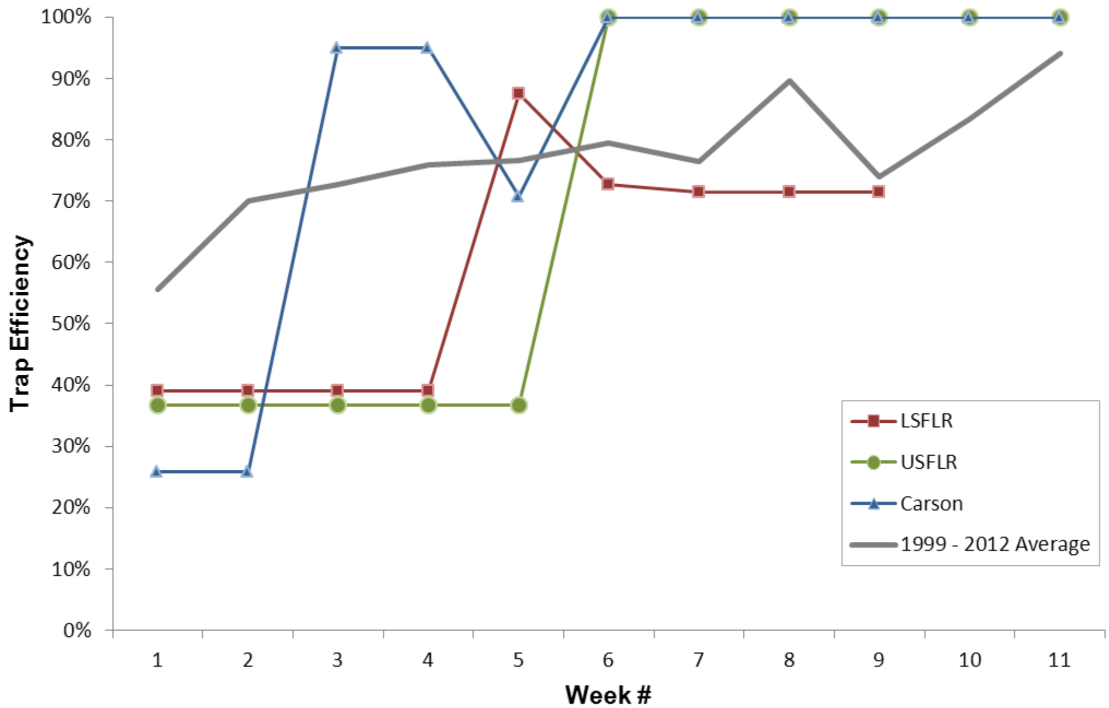

Figure 2. Summary of trap efficiencies for coho smolts during 2012 outmigrant trapping and the average of all four trapping sites for 1999-2012 in Little River, Humboldt County, California.

Table 2. Summary of the 2012 smolt captures and recaptures during the outmigrant trapping season in the Little River watershed, Humboldt County, California.

	Captured Smolts			Marked Smolts			Recaptured Smolts		
Site	**Coho**	**Steelhead**	**Cutthroat**	**Coho**	**Steelhead**	**Cutthroat**	**Coho**	**Steelhead**	**Cutthroat**
CC	599	2	0	484	2	0	371	2	0
RRC	1	0	1	1	0	1	1	0	0
LSFLR	602	0	1	383	0	1	274	0	1
USFLR	158	1	1	150	1	1	93	1	0
Total	1,360	3	3	1,018	3	3	739	3	1

However, when comparing the 2012 estimate with prior estimates for this cohort (i.e., Figure 3, blue bars), there is no clear trend or pattern among the sites. For CC and RRC the 2012 estimate appears below average but for USFLR and LSFLR it appears to be average.

Steelhead smolt numbers were similar among sites in 2012 and remained extremely low or not detected (Figure 4). The evident pattern at all sites over the thirteen years of monitoring is that smolt numbers have decreased. Similar to steelhead, cutthroat trout smolt numbers were very low in 2012 and have decreased over time at the four sites (Figure 5).

Excluding smolts, a total of 42,699 salmonids were captured at the four sites in Little River during the 2012 trapping season. These captures were summarized by site for each species and age class (Table 4). The numbers in this table are counts and not estimates. Young-of-year fish accounted for nearly all (96.95 %) captures, followed by 1+ fish (2.96 %), and adults (0.08 %).

Table 3. Smolt population estimates and confidence intervals (UCI = upper and LCI = lower) from outmigrant trapping 1999-2012 in the Little River watershed, Humboldt County, California.

		Carson Creek			Railroad Creek			LSF Little River			USF Little River		
Species	**Year**	**Estimate**	**95% UCI**	**95% LCI**	**Estimate**	**95% UCI**	**95% LCI**	**Estimate**	**95% UCI**	**95% LCI**	**Estimate**	**95% UCI**	**95% LCI**
Coho	1999	-	-	-	21	7	7	287	39	39	25	8	8
	2000	1,832	64	64	70	4	4	1,718	121	121	137	13	13
	2001	2,331	42	42	228	24	24	2,832	568	568	89	16	16
	2002	1,264	153	153	4	5	5	549	60	60	30	8	8
	2003	1,112	104	104	2*	-	-	950	483	483	621	157	157
	2004	2,181	155	155	83	24	24	1,411	109	109	927	904	904
	2005	1,519	126	126	1*	-	-	873	138	138	100	8	8
	2006	2,625	430	430	157	2	2	1,039	57	57	404	39	39
	2007	2,293	200	200	65	16	16	1,721	223	223	719	282	282
	2008	1,164	22	22	35	2	2	1,156	43	43	354	45	45
	2009	2,118	43	43	24	4	4	2,372	128	128	1,282	219	219
	2010	2,241	318	318	1*	-	-	1,283	308	308	1,439	502	502
	2011	729	127	127	0*	-	-	1,130	149	149	198	96	96
	2012	1,002	155	155	1	0	0	998	141	141	338	73	73
Steelhead	1999	-	-	-	45	31	31	101	52	52	50	14	14
	2000	12	6	6	17	4	4	61	15	15	76	8	8
	2001	23	2	2	21	7	7	36	16	16	51	11	11
	2002	93	23	23	12	8	8	41	21	21	53	9	9
	2003	61	59	59	0	-	-	50	38	38	40	37	37
	2004	14*	-	-	7*	-	-	39	21	21	73	51	51
	2005	39	27	27	12	11	11	48	33	33	60	52	52
	2006	2*	-	-	6	8	6	11	5	5	16	26	16
	2007	30	12	12	6	0	0	53	41	41	82	149	82
	2008	15	2	2	6	2	2	24	14	14	61	27	27
	2009	2*	-	-	1*	-	-	7	2	2	12	2	2
	2010	0	-	-	9	14	9	0	-	-	9	14	9
	2011	0	-	-	3	0	0	10	6	6	0	-	-
	2012	2	0	0	0	-	-	0	-	-	1	0	0
Cutthroat	1999	-	-	-	50	10	10	101	46	46	37	15	15
	2000	57	9	9	28	4	4	20	3	3	10	3	3
	2001	111	6	6	5	3	3	5	-	-	18	4	4
	2002	81	23	23	6	2	2	36	22	22	22	2	2
	2003	20	8	8	1*	-	-	36	42	36	17	26	17
	2004	22	7	7	8	1	1	21	7	7	27	18	18
	2005	49	7	7	0	-	-	9	1	1	7	3	3
	2006	31	4	4	14	4	4	4	0	0	25	43	25
	2007	4	0	0	2	0	0	1*	-	-	1*	-	-
	2008	5	2	2	0	-	-	1*	-	-	5	2	2
	2009	3*	-	-	4	6	4	0	-	-	2*	-	-
	2010	32	37	32	27	24	24	17	25	17	3*	-	-
	2011	1	0	0	0	-	-	1	0	0	18	20	18
	2012	0	-	-	1*	-	-	1	0	0	1*	-	-

Note: * indicates value is count, not estimate.

Table 4. Summary of unmarked salmonids captured during the 2012 trapping season in the Little River watershed, Humboldt County, California.

	Adult		YOY			1+		
Site	**Steelhead**	**Cutthroat**	**Coho**	**Chinook**	**Trout**	**Coho**	**Steelhead**	**Cutthroat**
CC	0	5	3,320	2,268	4,884	0	100	222
RRC	1	1	0	7,402	536	0	109	101
LSFLR	2	8	6,685	895	517	0	308	78
USFLR	5	13	1,932	5,675	7,284	0	226	122
Total	8	27	11,937	16,240	13,221	0	743	523

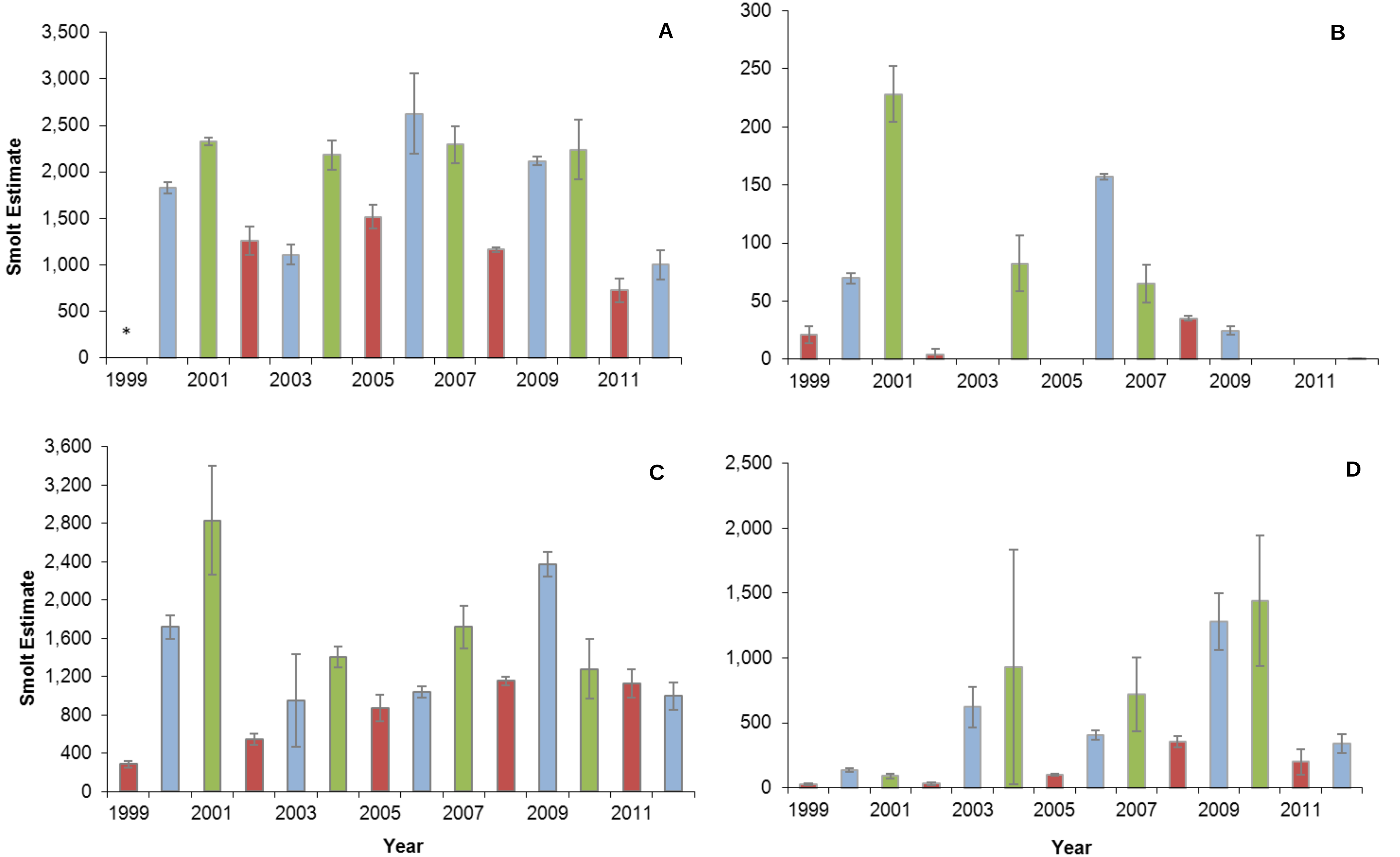

Figure 3. Outmigrant smolt estimates for coho salmon at Carson Creek (A), Railroad Creek (B), Lower South Fork Little River (C), and Upper South Fork Little River (D), 1999-2012. Colors indicate three distinct cohorts of coho and an asterisk (*) indicates year when sampling was not conducted.

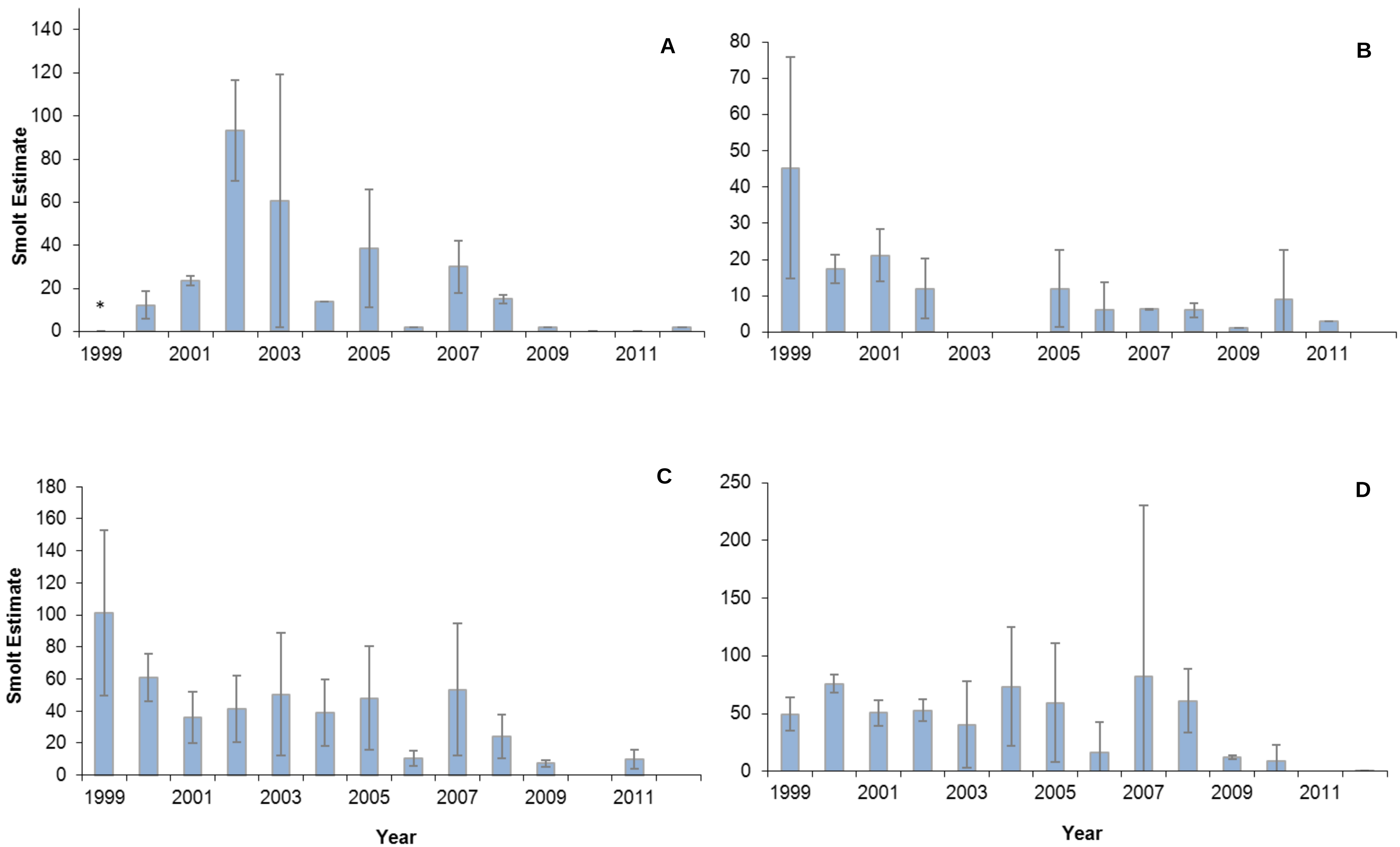

Figure 4. Outmigrant smolt estimates for steelhead trout at Carson Creek (A), Railroad Creek (B), Lower South Fork Little River (C), and Upper South Fork Little River (D), 1999-2012. Asterisk (*) indicates year when sampling was not conducted.

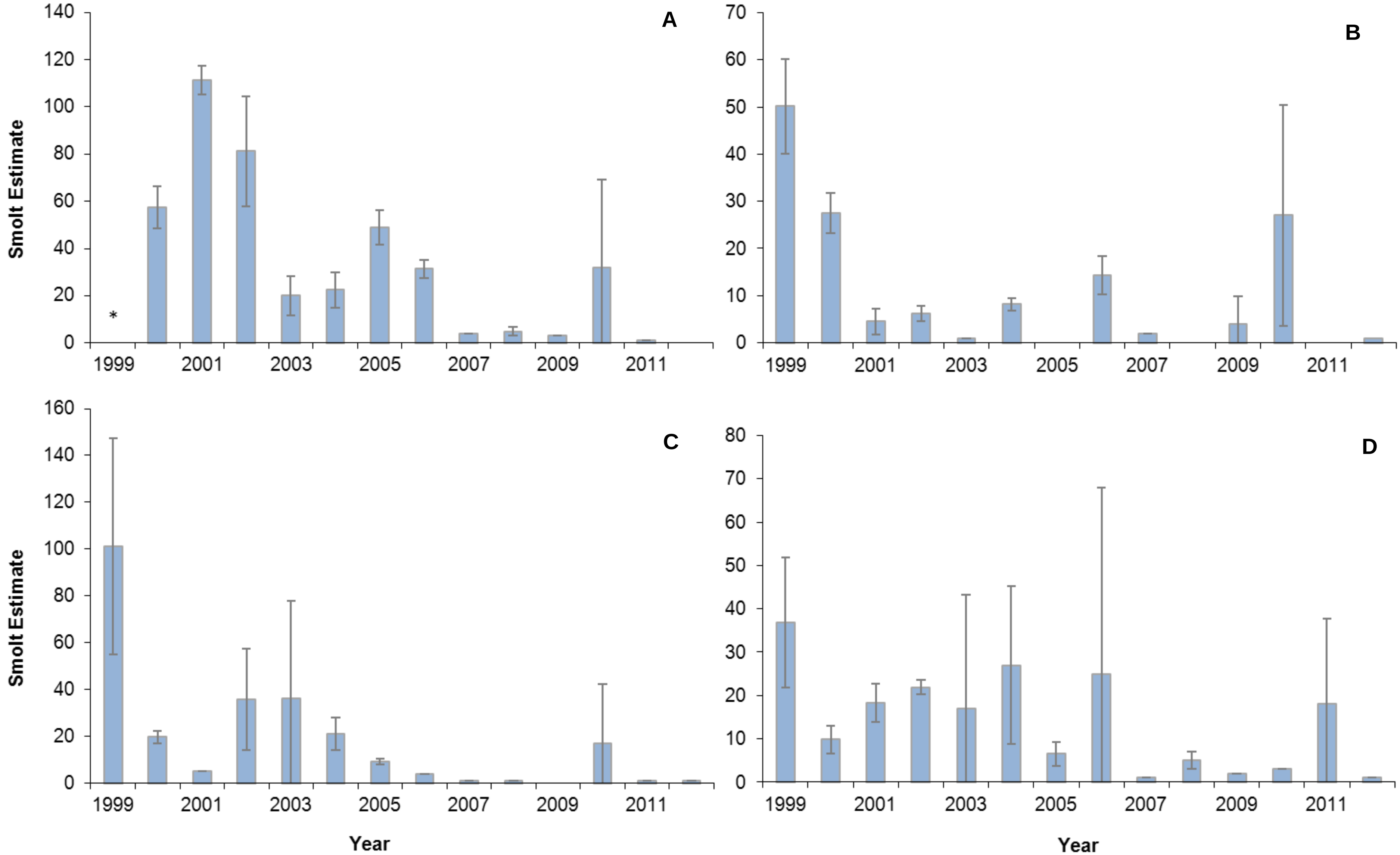

Figure 5. Outmigrant smolt estimates for cutthroat trout at Carson Creek (A), Railroad Creek (B), Lower South Fork Little River (C), and Upper South Fork Little River (D), 1999-2011. Asterisk (*) indicates year when sampling was not conducted.

California Coastal Chinook Abundance

Counts of juvenile Chinook moving through the outmigrant traps from 1999-2012 are presented below (Figure 6). Trap efficiencies were not estimated for Chinook so the numbers presented are hard counts. Overall, the number of juvenile Chinook outmigrants in Little River were average at half of the sites and relatively high at the others. The most dramatic increase in juvenile production was in Railroad Creek, where approximately 25 times the number of fish were observed compared to 2003, the only other time juveniles were captured at this site.

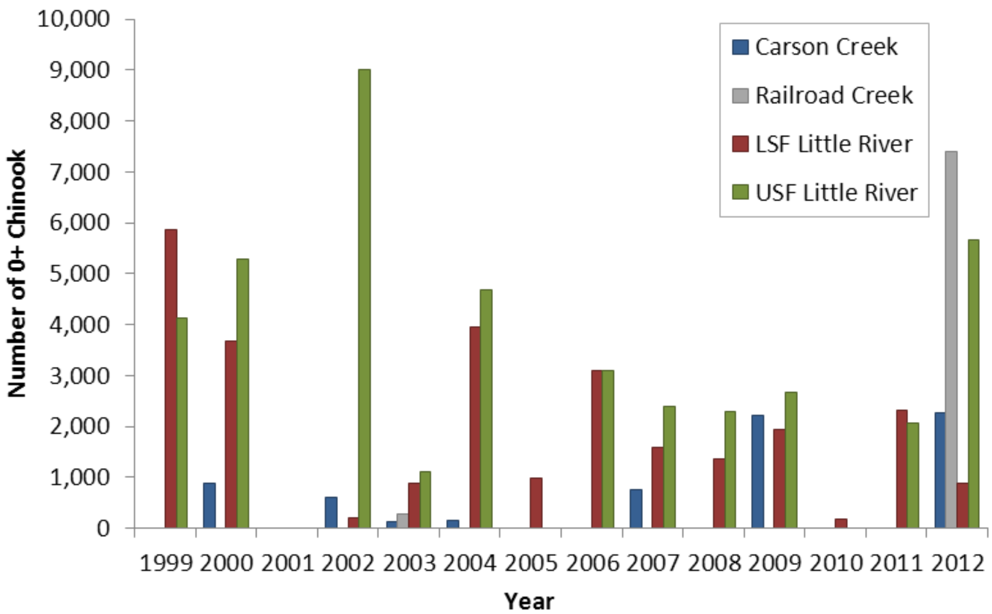

Figure 6. Frequency histogram of juvenile Chinook salmon counted during outmigrant trapping from 1999-2012 in Little River, Humboldt County, California.

Size and Condition

A total of 3,799 fish were measured and weighed during the 2012 outmigrant trapping season. A summary of the measurements collected is provided in Table 5. Based on field observations, the majority of fish handled appeared in good condition. Average fork lengths and average weights appeared similar among the four sites in Little River for all species and age classes compared to previous results.

Mortality

A total of 289 dead fish were documented during the 2012 outmigrant trapping season in Little River (Table 6). Those resulting from unknown cause(s) or monitoring activities were reported as mortalities (55.4%) and those clearly from predation (44.6%) were reported separately. Mortalities were observed for coho, Chinook, steelhead and trout. All but three (98 %) were YOY fish. Nineteen YOY mortalities resulted from handling. Predations were documented for coho, Chinook, steelhead and trout, and nearly all predations (99%) were YOY fish. Relative to the number of fish captured, the total number of dead fish accounted for < 1 % for all species. More details on the cause(s) of the observed mortalities and efforts to minimize them are described in the discussion section.

Table 5. Summary of length and weight for salmonids captured (N = sample size) during the 2012 outmigrant trapping season in Little River, Humboldt County, California.

		Age		Fork Length (mm)		Weight (g)	
Site Name	**Species**	**Class**	**N**	**Range**	**Mean**	**Range**	**Mean**
CC	Coho	Smolt	484	78 - 133	102	6.1 - 21.5	11.4
	Coho	YOY	240	33 - 48	39	0.2 - 1.2	0.5
	Steelhead	Smolt	2	148 - 170	159	30.4 - 47.0	38.7
	Steelhead	1+	100	70 - 165	96	4.0 - 48.0	11.1
	Cutthroat	Smolt	0	-	-	-	-
	Cutthroat	1+	222	78 - 192	132	5.4 - 84.7	26.1
	Cutthroat	Adult	5	217 - 273	247	97 - 224.3	159.3
	Chinook	0+	81	38 - 44	40	0.3 - 0.8	0.5
	Trout	YOY	213	26 - 65	31	0.1 - 3.5	0.3
RRC	Coho	Smolt	1	-	108	-	13.2
	Coho	YOY	0	-	-	-	-
	Steelhead	Smolt	0	-	-	-	-
	Steelhead	1+	108	71 - 150	93	3.9 - 41.5	10.1
	Cutthroat	Smolt	1	-	154	-	32.2
	Cutthroat	1+	101	86 - 199	120	8.0 - 97.4	21.4
	Cutthroat	Adult	1	-	225	-	121.1
	Chinook	0+	100	37 - 53	41	0.3 - 1.4	0.6
	Trout	YOY	40	28 - 68	32	0.1 - 3.6	0.4
LSFLR	Coho	Smolt	383	69 - 130	96	3.2 - 24.3	9.8
	Coho	YOY	187	35 - 52	39	0.3 - 2.0	0.6
	Steelhead	Smolt	0	-	-	-	-
	Steelhead	1+	284	64 - 173	92	2.9 - 54.0	10.3
	Cutthroat	Smolt	1	-	173	-	48.2
	Cutthroat	1+	78	75 - 184	135	4.0 - 71.3	29.8
	Cutthroat	Adult	8	219 - 304	258	95.0 - 325.1	174.9
	Chinook	0+	26	39 - 43	41	0.4 - 0.8	0.6
	Trout	YOY	46	28 - 67	35	0.1 - 3.2	0.6
USFLR	Coho	Smolt	151	80 - 125	99	5.3 - 20.0	10.7
	Coho	YOY	177	32 - 54	40	0.2 - 2.0	0.6
	Steelhead	Smolt	1	-	181	-	50.3
	Steelhead	1+	221	62 - 190	93	2.8 - 75.1	11.1
	Cutthroat	Smolt	1	-	188	-	63.1
	Cutthroat	1+	121	82 - 183	124	6.5 - 65.1	23.2
	Cutthroat	Adult	13	237 - 310	268	145.6 - 295.6	205.8
	Chinook	0+	155	35 - 59	41	0.3 - 1.7	0.6
	Trout	YOY	247	26 - 68	31	0.1 - 3.6	0.3

Table 6. Summary of salmonid mortality during 2012 outmigrant trapping in Little River, Humboldt County, California.

				Mortality		Predation		Total	
Site	**Species**	**Age Class**	**Captured (#)**	**#**	**%**	**#**	**%**	**#**	**%**
CC	Coho	Smolt	599	0	0.00%	1	0.17%	1	0.17%
	Coho	YOY	3,320	5	0.15%	3	0.09%	8	0.24%
	Chinook	YOY	2,268	2	0.09%	3	0.13%	5	0.22%
	Cutthroat	Adult	5	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	Smolt	0	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	1+	222	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Adult	0	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Smolt	2	0	0.00%	0	0.00%	0	0.00%
	Steelhead	1+	100	0	0.00%	0	0.00%	0	0.00%
	Trout	YOY	4,884	11	0.23%	1	0.02%	12	0.25%
RRC	Coho	Smolt	1	0	0.00%	0	0.00%	0	0.00%
	Coho	YOY	0	0	0.00%	0	0.00%	0	0.00%
	Chinook	YOY	7,402	26	0.35%	47	0.63%	73	0.99%
	Cutthroat	Adult	1	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	Smolt	1	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	1+	101	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Adult	1	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Smolt	0	0	0.00%	0	0.00%	0	0.00%
	Steelhead	1+	109	0	0.00%	0	0.00%	0	0.00%
	Trout	YOY	536	2	0.37%	1	0.19%	3	0.56%
LSFLR	Coho	Smolt	602	1	0.17%	0	0.00%	1	0.17%
	Coho	YOY	6,685	10	0.15%	9	0.13%	19	0.28%
	Chinook	YOY	895	1	0.11%	3	0.34%	4	0.45%
	Cutthroat	Adult	8	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	Smolt	1	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	1+	78	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Adult	2	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Smolt	0	0	0.00%	0	0.00%	0	0.00%
	Steelhead	1+	308	1	0.32%	0	0.00%	1	0.32%
	Trout	YOY	517	3	0.58%	0	0.00%	3	0.58%
USFLR	Coho	Smolt	158	1	0.63%	0	0.00%	1	0.63%
	Coho	YOY	1,932	20	1.04%	8	0.41%	28	1.45%
	Chinook	YOY	5,675	35	0.62%	27	0.48%	62	1.09%
	Cutthroat	Adult	13	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	Smolt	1	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	1+	122	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Adult	5	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Smolt	1	0	0.00%	0	0.00%	0	0.00%
	Steelhead	1+	226	0	0.00%	1	0.44%	1	0.44%
	Trout	YOY	7,284	42	0.58%	25	0.34%	67	0.92%
Total	Coho	Smolt	1,360	2	0.15%	1	0.07%	3	0.22%
	Coho	YOY	11,937	35	0.29%	20	0.17%	55	0.46%
	Chinook	YOY	16,240	64	0.39%	80	0.49%	144	0.89%
	Cutthroat	Adult	27	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	Smolt	3	0	0.00%	0	0.00%	0	0.00%
	Cutthroat	1+	523	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Adult	8	0	0.00%	0	0.00%	0	0.00%
	Steelhead	Smolt	3	0	0.00%	0	0.00%	0	0.00%
	Steelhead	1+	743	1	0.13%	1	0.13%	2	0.27%
	Trout	YOY	13,221	58	0.44%	27	0.20%	85	0.64%

Migration Timing

A frequency histogram was created using daily smolt captures (i.e., not estimates) to summarize the timing of coho smolt migration at the four monitored sites in Little River (Figure 7). It is apparent that outmigrant traps were installed at or before the peak of the coho smolt migration. The majority (82.4 %) of coho smolts observed emigrated from the Little River tributaries during the month of May. The observed migration peaked during the first week of May at CC and during the second week in May at LSFLR and USFLR.

Coho Overwinter Survival

Apparent overwinter survival was calculated for LSFLR and USFLR based on 2011 summer juvenile population estimates and 2012 smolt estimates (Table 7). Both sites had identical apparent overwinter survival (12%) during the 2012 water year which was in the lower quartile among the values documented at these sites. Overwinter survival could not be calculated for CC (see Methods for justification) or RRC due to insufficient capture of coho.

Species Composition and Abundance

Ten species (7 fish and 3 amphibians) were captured in the outmigrant traps during the 2012 season in the Little River watershed (Table 8). Fifty-seven percent of the fish species were in the genus *Oncorhynchus*. The remainder of species were incidental captures of non-target species, primarily lamprey and amphibians. Species composition in 2012 was similar with that recorded in years past.

Stream Temperature

Water temperature was monitored for 41 days (May 19 – June 30) at the CC trapping site, during which, a total of 860 measurements were collected. Water temperature was monitored for 38 days (May 22 – June 30) at the RRC, LSFLR, and USFLR trapping sites, during which, a total of 800 measurements were collected. This monitoring period accounted for 55%, 62%, 62%, and 51% of the outmigrant trapping seasons, respectively. Mean daily water temperatures were calculated from these data and temperature profiles were created (Figure 8). Throughout the trapping season, water temperatures were similar among sites, all increased as expected, and temperatures stayed within the thermal tolerances for captured species.

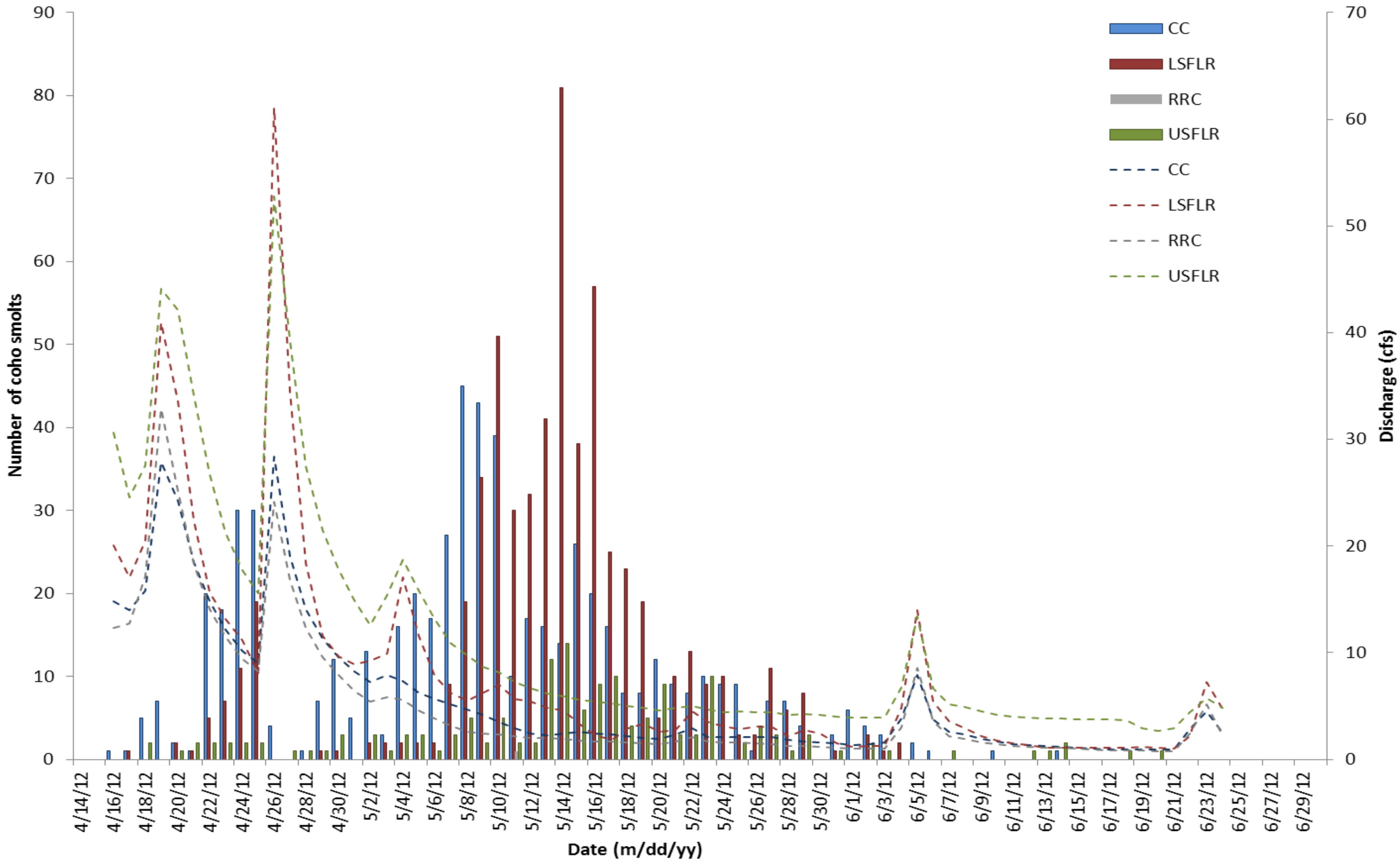

Figure 7. Coho outmigrant timing (vertical bars) and discharge (dashed lines) during the 2012 trapping season in Little River, Humboldt County, California.

Table 7. Summary of apparent overwinter survival estimates for coho from 1999-2011 in the Little River watershed, Humboldt County, California.

Site	Smolt Year	Coho (YOY) Summer Population	Coho Smolt Winter Population	Apparent Over-winter Survival Estimate	Drainage Area (Miles^2)	Length of Habitat (Miles)	Summer Population (Fish/Mile)	Winter Population (Fish/Mile)
RRC	1999	250	21	8%	2.8	1.2	208	18
	2000	391	70	18%	2.8	0.5	782	139
	2001	195	228	117%	2.8	0.5	390	456
	2002	7	4	57%	2.8	0.5	14	8
	2003	1,539	2*	-	2.8	0.7	2,199	-
	2004	279	83	30%	2.8	0.7	399	118
	2005	0	1*	-	2.8	0.7	0	-
	2006	661	157	24%	2.8	0.7	944	224
	2007	153	65	42%	2.8	0.7	219	93
	2008	162	35	22%	2.8	0.7	231	50
	2009	95	24	25%	2.8	0.7	136	34
	2010	24	1	4%	2.8	0.7	34	1
	2011	0	0	-	2.8	0.7	0	0
	2012	0	1	-	2.8	0.7	0	1
LSFLR	1999	4,310	287	7%	5.3	2.2	1,959	130
	2000	8,456	1,718	20%	5.3	2.2	3,844	781
	2001	5,103	2,832	55%	5.3	2.2	2,320	1,287
	2002	928	549	59%	5.3	2.2	422	250
	2003	14,322	950	7%	5.3	2.2	6,510	432
	2004	6,320	1,411	22%	5.3	2.2	2,873	642
	2005	4,172	873	21%	5.3	2.2	1,896	397
	2006	6,912	1,039	15%	5.3	2.2	3,142	472
	2007	9,785	1,721	18%	5.3	2.2	4,448	782
	2008	7,943	1,156	15%	5.3	2.2	3,610	525
	2009	10,371	2,372	23%	5.3	2.2	4,714	1,078
	2010	9,937	1,283	13%	5.3	2.2	4,517	583
	2011	2,010	1,130	56%	5.3	2.2	914	514
	2012	8,592	998	12%	5.3	3.0	2,864	333
USFLR	1999	820	25	3%	5.7	1.6	513	16
	2000	1,279	137	11%	5.7	1.6	799	86
	2001	389	89	23%	5.7	1.6	243	56
	2002	197	30	15%	5.7	1.6	123	19
	2003	8,275	621	8%	5.7	2.0	4,138	310
	2004	3,018	927	31%	5.7	2.0	1,509	464
	2005	1,137	100	9%	5.7	2.0	569	50
	2006	1,881	404	21%	5.7	2.0	941	202
	2007	3,245	719	22%	5.7	2.0	1,623	360
	2008	1,660	354	21%	5.7	2.0	830	177
	2009	5,987	1,282	21%	5.7	2.0	2,994	641
	2010	3,501	1,439	41%	5.7	2.0	1,751	720
	2011	417	198	47%	5.7	2.0	209	99
	2012	2,914	338	12%	5.7	2.0	1,457	169

* hard count, estimate not calculated

Table 8. Summary of species captured during outmigrant trapping in the Little River watershed, 2004-2012.

		Year													
Common Name	**Scientific Name**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Coho Salmon	*Oncorhynchus kisutch*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Chinook Salmon	*Oncorhynchus tshawytscha*	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Steelhead	*Oncorhynchus mykiss*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Coastal Cutthroat Trout	*Oncorhynchus clarki clarki*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pacific Lamprey	*Lampetra tridentata*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Western Brook Lamprey	*Lampetra richardsoni*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Pacific Giant Salamander	*Dicamptodon tenebrosus*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tailed Frog	*Ascaphus truei*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Red-legged frog	*Rana aurora*	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y
Rough-skinned Newt	*Taricha granulosa*	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N
Prickly Sculpin	*Cottus asper*	N	Y	Y	N	N	N	Y	N	Y	N	Y	N	N	Y
Three-Spined Stickleback	*Gasterosteus aculeatus*	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N

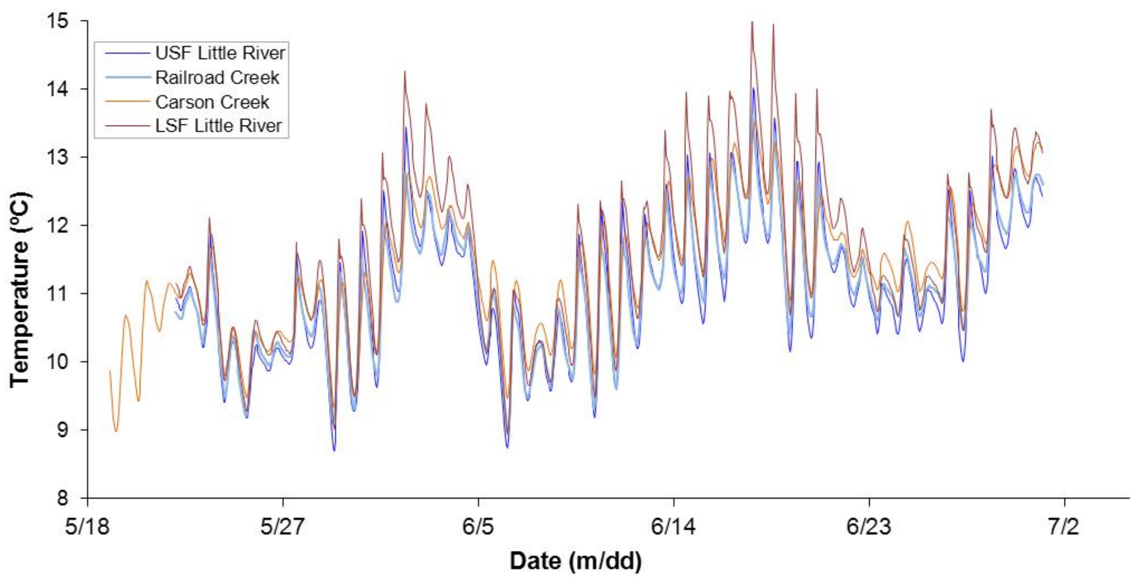

Figure 8. Daily water temperature readings at the four trapping sites in the Little River watershed, 2012.

Discussion

Population Estimates

Based on the three year life history of coho (Murphy and Meehan, 1991), the 2012 population estimates in Little River was the fifth time this cohort was estimated. When comparing the population estimates of this cohort over the entire monitoring period and comparing it to the two other cohors; this cohort appears to be of moderate strength and producing a fairly consistent number of smolts, including a pronounced increase in 2009 at USFLR and LSFLR. Despite the second consecutive decrease at CC and RRC and a decrease to average levels at USFLR and LSFLR since 2009 (Figure 3), it is unclear if this change is part of a natural fluctuation in smolt production for this cohort. Further monitoring will help answer this question. Overall, the observed dynamics of smolt production at the monitored tributaries in Little River is presumably a result of multiple factors, including climate, ocean conditions, predator-prey dynamics, spawning and rearing habitat availability, and anthropogenic disturbances, acting synergistically. A comprehensive analysis is needed to better understand the observed dynamics of coho smolt populations in Little River.

Steelhead and cutthroat population estimates in 2012 were among the lowest documented over the thirteen years of monitoring in Little River (Figures 4 & 5) and the overall trend suggests these species may be declining. However, an alternate explanation to this apparent trend is that the start of OMT trapping seasons has shifted to a later date generally since 2005 and may have missed the peak of outmigrants for these species. This explanation seems plausible considering the largest estimates occurred during years with the earliest initiation dates (Table 1). Another potential explanation is that the apparent trends are confounded by low sample sizes. The numbers captured are relatively low with large confidence intervals, and may not allow for adequately assessing the population trends for these two species. One thing is clear, the variation in smolt estimates and apparent declines of steelhead and cutthroat in Little river are difficult to explain and presumably attributed to the interaction of multiple factors like those stated above for coho and a detailed analysis is necessary to better understand the observed dynamics of smolts in Little River.

There is little concern that the relatively late start of the trapping season in 2012 had a considerable effect on the coho smolt estimate in Little River. Outmigrant trapping was also conducted in 2012 at Prairie Creek. This site was trapped from late February through July and approximately 6% of the coho smolts emigrated by April (M. Sparkman, pers. comm.). Given this finding and assuming similar phenology in coho smolt emigration between sites, the 2012 trapping efforts in Little River was likely sufficient to estimate approximately 94% of the actual number of coho smolts.

In 2012, high flows during the trapping period likely had a relatively low influence on smolt captures compared to the apparent influence in years past. Flows during 2012 were consistently low with only two small events at the beginning of the season (Figure 7). High flows can negatively influence outmigrant estimates because smolts may continue emigrating and evade capture by swimming over the V-notch weir. Furthermore, during extreme high flow events, the traps are typically removed to prevent equipment damage or loss, and during these inoperable times fish can't be captured. The relationship between higher flows and lower capture is consistent with data from previous years and undoubtedly contributed to the accuracy of the population estimates reported in 2012. However, considering there was no interruption of trapping in 2012 the potential negative affect that high flows had on 2012 smolt estimates was minimal.

Despite the deficiencies noted above, outmigrant traps are an excellent tool for collecting downstream migrants and is currently the best opportunity GDRCo has available to collect information pertaining to coho smolt production. The box trap, McBain ramp, pipe and weir system efficiently trap these streams during low and normal flow.

Coho Overwinter Survival

The results in 2012 for apparent overwinter survival of coho should be interpreted cautiously. The apparent overwinter survival estimates are based on the assumption of no immigration or emigration of juveniles between the time of the summer estimate survey and the installation of the outmigrant traps the subsequent spring. Increasing evidence indicates that some proportion of coho, in north coastal California streams, move downstream in fall and winter (S. Ricker, pers. comm. and D. Gale, pers. comm.). This finding violates the assumption of how overwinter survival was calculated and may result in a negative bias on the reported values. The proportion of fish emigrating from the sites monitored in Little River is unknown, and is likely influenced by factors including population density, winter flows, and the amount of suitable winter rearing habitat. Therefore, additional information is needed to calculate a more accurate estimate of coho overwinter survival.

In Little River there is some evidence to suggest that flows may influence apparent overwinter survival. There is a seemingly inverse relationship from 1999-2010 between discharge and apparent overwinter survival (GDRCo, 2011), which seems to be further supported by results from 2012. The lowest average apparent overwinter survivals occurred during the 1999 and 2003 smolt cohorts when the Little River peak flow events exceeded 9,400 and 8,500 cfs, respectively. Presumably, high flow events are forcing juveniles downstream before the trapping season and during the season when the traps aren't operational (i.e., peak flow events). Therefore, the true overwinter survival in the Little River watershed is likely higher than that reported here, assuming that fish are utilizing other portions of the Little River watershed (i.e. the estuary). Conversely, the highest average apparent overwinter survival was for the 2001 smolt cohort when the peak event (788 cfs) was the lowest since the inception of outmigrant trapping by GDRCo in Little River. In 2012, the moderate peak event (4,460 cfs) combined with the prolonged relatively high flows that also delayed trapping initiation likely contributed to the relatively low apparent overwinter survival.

Other factors that could influence both true mortality and the proportion of fish that emigrate prior to trapping include temperature, density of fish, availability of habitat, food upstream of the trapping sites, and inoperable days during the trapping season. Without an estimate of the proportion of early (pre-trapping) downstream migration, it is difficult to assess what factors, if any, are influencing that movement, or what the true overwinter survival and true smolt production is in Little River. The abundance and survival rate of fish that leave the system prior to initiating trapping is not known, however, Little River has a relatively intact estuary and the estuarine survival rate is presumably high. These factors may have contributed to the apparent overwinter survival observed during 2012 in Little River and further assessment is needed to better understand the observed dynamics.

Size and Condition

The sizes and weights documented for salmonids in Little River during the 2012 outmigrant trapping season were similar to those reported in years past. The lack of any obvious change in fish size and condition suggests that there have been no significant changes to the available rearing habitat in Little River. Salmonid growth increases at varying rates depending on the abundance of aquatic insects and plant life during critical rearing periods (Murphy and Meehan 1991). Size can also be influenced by density related competition (Imre et al. 2005). The seemingly consistent size and length among salmonids captured at the trap sites suggests that these factors are relatively constant in the Little River watershed.

Migration Timing

The migration timing observed in Little River was expected considering the observed flows, was similar to that observed in past years, and consistent with peaks observed in other nearby watersheds (GDRCo, 2012, Sparkman, 2011). Factors that tend to affect the timing of migration include the size of the fish, flow conditions, water temperature, dissolved oxygen levels, day length, and availability of food (Shapovalov and Taft, 1954). These factors presumably contributed to the 2012 outmigrant phenology observed in Little River.

Mortalities

Several factors may have contributed to the mortalities observed related to the trapping and handling process during the 2012 outmigrant trapping in Little River (Table 6), however, the specific reason(s) for many of these mortalities is unclear. Predation is clearly one factor. Some of the other potential reasons for fish mortality while operating the outmigrant traps may include improper handling, injury while marking, trapping injury, debris loading in the trap box, and employee inexperience. Below we considered the potential role of each of these factors in the observed mortality in 2012.

A few of the observed mortalities resulted from handling during the 2012 trapping season. All of these were specifically from netting YOY fish out of the back box when large numbers of fish had been captured. While netting high densities of fish out of the trap box, it is difficult to avoid accidentally pinching a YOY fish against the box with the hoop of the net. Efforts will continue to be made into the future to eliminate all mortalities resulting from handling procedures.

There was no evidence to suggest any of the mortalities were from sedation or marking techniques. Throughout the duration of the season, marked smolts were held upstream in the release device (i.e., live box) to observe any delayed mortality due to handling or marking. None were observed.

It is also unlikely that employee training and experience negatively contributed to the observed mortality in 2012. In fact, the low mortality rates in 2012 may be partly attributable to the focused effort of our experienced field crew. All crew members involved in conducting outmigrant trapping in Little River received sufficient training and all six had multiple years of direct experience using the trapping equipment and following the field protocols. This factor is easiest to control with proper training and supervision of field crews in fish handling techniques, and the company's emphasis on the importance of this issue.

The observed mortalities in 2012 were not associated with high flow events and the corresponding debris loading in the trap box. Mortality usually associated with heavy debris loading in the trap-box in Little River typically occurs during periods of high winds and high flows (GDRCo, 2011). Young-of-year fish are especially susceptible to this source of mortality. The undetermined mortalities in 2012 occurred throughout the season and field observations did not observe routine or excessive debris accumulation in the trap boxes. Furthermore, during periods of heavy rain or wind, the traps were checked a second time in the later afternoons to clear accumulated debris from the live-box in an attempt to minimize mortalities associated with debris loading. The unlikely association of debris loading and the observed mortalities suggests an alternate cause.

Predation in the trap box is difficult to prevent and was a major cause of the total mortality in 2012, despite efforts to minimize predation once fish had been trapped. During the 2012 trapping season we continued to implemented two tactics to minimize predation in the trap. First, we used a small screen cylinder to create a refuge, within the forward trap-box, such that only smaller fish can enter and seek shelter from larger fish which are excluded. Second, cover (i.e., cobbles) was also provided in the forward trap-box. This cover was intended to allow smaller fish an alternative means to hide from larger fish in the trap-box.

While the mortalities observed in 2012 were low, both in percent of fish handled and relative to the take limits provided in our Section 10a permit (2% for salmon and 3% for trout), GDRCo continues to make efforts to further reduce mortality associated with the monitoring efforts. For example, the trapping equipment will be inspected for potential fish hazards and repaired as needed prior to deployment in 2013. Furthermore, we will continue to develop and implement new improvements in the trap design and handling procedures as part of our ongoing efforts. Despite the permitted mortalities documented in 2012, GDRCo will strive towards lowering the mortality associated with future trapping efforts.

Potential Research Improvements

GDRCo continues to research and explore options that would improve our methods and data. One way to improve the methodology is by constructing permanent weirs in these sub-basins. This would improve the confidence of the smolt estimates by providing a flexible initiation date and efficient trapping under all but the highest flows. Correlating this to our summer population estimates would lead to reliable overwinter survival estimates, giving us better insight into the quality of the winter habitat in the Little River watershed.

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